**Quantifying synergies between multiple stressors and biodiversity loss on the functioning of freshwater microbial communities**

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**Full Project Description**

Substantial evidence exists across a wide variety of regions and taxonomic groups that ecosystems with higher levels of biodiversity are also more productive and stable. Biodiversity loss, driven by factors such as land use change, pollution, and invasive species, is occurring in parallel with rapid global environmental change (e.g. warming, acidification, eutrophication) yet our understanding of the potential for synergies between these multiple facets of environmental change on ecosystem functioning is severely limited because most experimental manipulations of biodiversity loss are conducted under ambient environments.

Theory suggests that variance in traits that determine environmental tolerance should play a key role in mediating the impacts of abiotic change on ecological dynamics and ecosystem functioning. If species loss occurs independently of environmental tolerance traits (as might be expected from the effects of land-use change, nutrient loading, or invasive species), then the additional impact of changes in the abiotic environment could result in pronounced declines in ecosystem function, because communities with fewer species will have a lower probability of including those with traits that enable them to cope with the novel environmental regime. As the number of environmental stressors rise, an increasingly large number of species (and traits) may be required to maintain ecosystem functioning.

This project will test these hypotheses using high-throughput experiments with microbial communities. We will isolate a wide range of microbes from freshwater ecosystems that have been subjected to diverse environmental stressors. We will capitalise existing experiments including long-term, warmed mesocosms in Dorset, geothermally warmed streams in Iceland and the Llyn Brianne experimental flumes. We will also utilize CEH’s Intelligent River Network GIS tool to identify catchments that have been subjected to range of anthropgenic stressors (e.g. nutrient loading, heavy metal contamination, acidification). We will quantify the tolerance of each isolate to variation in each stressor as well as factorial combinations of stressors using high-throughput techniques in the state-of-the-art microbial ecology laboratories at the University of Exeter, Cardiff University and CEH. Isolates will then be assembled into communities across a log2 scale of taxonomic richness to simulate biodiversity loss and exposed to the range of abiotic stressors in factorial experiments. Ecosystem functioning will be quantified as community biomass and total respiratory CO2 flux measured using high-throughput respirometry. We will use information on the environmental tolerance traits of the isolates to understand how and why the diversity-functioning relationship is altered by multiple stressors as well as any covariance or trade-offs between environmental tolerance traits, which can be used to identify key taxonomic groups to target for conservation.

**Real Life challenges this project will address**

Microbial communities are the foundation of freshwater food webs and their biodiversity and productivity provide services that are of incalculable value to human societies – from clean water to climate regulation and fisheries production. In stark contrast to their vital importance, the impacts of environmental change and biodiversity loss on freshwater microbial communities remain poorly understood and grossly understudied. This project will address this critical knowledge gap by quantifying the impacts of synergies between biodiversity loss and multiple abiotic stressors on the functioning of freshwater microbial communities.

**What you should know about this project**

Climate change and the loss of biodiversity through human activities (e.g., land-use change, pollution, invasive species) are profound threats to the functional integrity of the Earth′s ecosystems. These factors are however invariably investigated separately, ignoring the potential for synergistic effects of biodiversity loss and climate change on ecosystem functioning. This project will be the first to tackle this critical knowledge gap. The student will be supervised by world–leading experts in evolutionary ecology, microbiology, and molecular biology and will have the opportunity to place their work in societal context through collaboration with the Freshwater Habitats Trust.

**What expertise you will develop**

The student will develop expertise in environmental microbiology, molecular biology and ecophysiology. This will include field sampling and microbial isolation, microbiological and molecular biology techniques, handling and analysis of large datasets, statistics, writing and data presentation. The student will engage with the Freshwater Habitats Trust and other stakeholders engaged in research with the supervisory team (Defra, Water Industry, Environment Agency).

**Why this project is novel**

Current understanding about the impacts of biodiversity loss on ecosystem functioning and service provision in freshwater ecosystems is based studies that manipulate taxonomic diversity under ambient conditions. Consequently, our understanding of the potential for synergies between multiple facets of environmental change on ecosystem functioning is severely limited. If biodiversity loss occurs independently of species environmental tolerance traits – e.g. via habitat loss or invasive species – then the impact of multiple abiotic stressors (a key feature of global environmental change) could result in pronounced declines in ecosystem function, because communities with fewer species will have a lower probability of including those taxa with traits that enable them to cope with the novel environmental regime.

**Rest of Supervisory Team:**

**Stakeholder Organisation** Freshwater Habitats Trust

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